

Amendments to the Drawings:

The attached drawing sheets include one set of replacement drawings for Figures 3A, 3B and 4A-4C and a set of annotated sheets showing the changes made to Figures 3A, 3B and 4A-4C.

Figure 4A has been corrected such that reference numeral 35 on the upper right region of the Figure has been replaced with reference numeral 33.

In addition, each of Figures 3A, 3B and 4A-4C have been amended to include the legend -- Prior Art --.

Attachment at end of paper in Appendix:

Replacement Sheets

Annotated Sheets Showing Changes

REMARKS/ARGUMENTS

This letter is responsive to the Office Action mailed on July 25, 2005. Accordingly, this response is considered as being timely filed.

Amendments made to the Specification

The Applicant has made amendments to paragraphs [0015] and [0016] in the Summary of the Invention section to conform to the independent claims as amended herein. The Applicant has further amended paragraphs [0020], [0057], [0074], [0080], [0106], [0108], [0128], [0131], [0142] and [0149] to correct inadvertent typographical errors.

Amendments made to the Drawings

The Applicant includes replacement sheets for Figures 3A, 3B, and 4A-4C to indicate that these Figures depict prior art. The Applicant has also amended Figure 4A so that the reference numeral in the upper right portion of the Figure is 33 and not 35.

Claim Amendments

In this response, claims 1, 3-5, 21 and 23-25 have been amended. Claims 2 and 22 have been cancelled without prejudice. Claims 13-15 and 31-33 are withdrawn. New claims 39 to 42 have been added.

Claim 1 now recites an off-axis projection system for displaying an optical image on a display surface based on input image data. The off-axis projection system comprises: an image processing unit for receiving the input image data and generating distortion-compensated image data; a projection light engine coupled to the image processing unit for receiving the distortion-compensated image data and projecting a distortion-

compensated optical image that corresponds to the distortion-compensated image data; and, an optical reflection assembly coupled to the projection light engine. The optical reflection assembly comprises at least one curved mirror including an aspherical rotationally non-symmetric mirror having a vertically oriented concave surface and a horizontally oriented surface with at least one of a varying degree of concave and convex curvature on an upper surface that smoothly transitions to a varying degree of convex curvature on a lower surface for reducing spatial distortion on the displayed optical image. The at least one curved mirror is positioned in the optical path of the distortion-compensated optical image emerging from a projection lens for producing a displayed optical image with reduced distortion on the display surface. The image processing unit is adapted to distortion-compensate the optical image represented by the input image data such that when the distortion-compensated optical image is projected through the projection light engine and reflected off the optical reflection assembly, the optical and geometric distortions associated with the projection light engine and the optical reflection assembly are substantially eliminated in the displayed optical image. Support for this claim amendment is claim 2 and the corresponding portions of the description in the application as originally filed.

Claim 21 is an independent method claim that has been amended in a similar fashion to claim 1. Support for the amendment made to claim 21 is claim 22 and the corresponding portions of the description in the application as originally filed.

Claims 3-5 have been amended to refer to the aspherical rotationally non-symmetric curved mirror rather than simply referring to the curved mirror. Claims 23-25 are corresponding method claims that have been amended in a similar fashion.

Claims 3 and 23 have also had their claim dependencies amended due to the cancellation of claims 1 and 21 respectively. Claim 3 now depends from claim 1 and claim 23 now depends from claim 21.

The Applicant has added new claims 39-42. New claim 41 recites a curved mirror for use in an optical reflection assembly used in a projection system. The curved mirror is an aspherical rotationally non-symmetric mirror having a vertically oriented concave surface and a horizontally oriented surface with one of a varying degree of concave and convex curvature on an upper surface that smoothly transitions to a varying degree of convex curvature on a lower surface for reducing spatial distortion on a displayed optical image. Support for this claim amendment is in paragraphs 75-77 and Figures 7A-7C of the application as originally filed.

New claim 40 recites that the aspherical rotationally non-symmetric mirror has a small degree of horizontal convex curvature on an upper portion and a larger degree of horizontal convex curvature on a lower portion for reducing spatial distortion on the displayed optical image. Support for this claim amendment is in paragraphs 75-77, Figures 7A-7C, and claim 3 of the application as originally filed

New claims 41 and 42 recite that the curved mirror is used in an optical reflection assembly used in one of a front projection system and a rear projection system. Support for this claim amendment is in paragraph 72 and Figure 6 of the application as originally filed.

Drawings

In paragraph 3 of the Office Action, the Examiner objected to Figure 4A for not including reference numeral 33. The Examiner is of the opinion that Figure 4A includes two reference numerals 35.

In response, the Applicant submits a replacement sheet for Figure 4A to replace the reference numeral 35 in the upper right region of Figure 4A with reference numeral 33. This amendment is supported by paragraph 66 on page 12 of the application as filed.

In paragraph 4 of the Office Action, the Examiner objected to Figure 14A in which the projection system is labeled 400. The Examiner argues that in paragraph 106 of the specification, the projection system is referenced with reference numeral 300 and that this reference numeral should be used in Figure 14A.

In response, the Applicant respectfully submits that a typographical error was made in line 2 of paragraph 106 and that the projection system should be identified with reference numeral 400 and not 300. Accordingly, the Applicant has amended this portion of the specification to correctly use reference numeral 400 and has not made any reference numeral changes to Figure 14A.

In paragraph 5 of the Office Action, the Examiner objected to Figures 3A, 3B, 4A, 4B and 4C and argued that these figures should be designated by a legend such as --Prior Art--.

In response, the Applicant has added the legend -- Prior Art -- to Figures 3A, 3B, 4A, 4B and 4C. Both marked up and clean replacement sheets are provided herein.

Specification

The Examiner stated that the lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors and requested the Applicant's cooperation in correcting any errors of which the Applicant may become aware in the specification.

In response, the Applicant has reviewed the specification and submits corrections for minor typographical errors for paragraphs [0020], [0057], [0074], [0080], [0106], [0108], [0128], [0131], [0142] and [0149].

Claim Rejections – 35 USC § 102

In paragraph 6 of the Office Action, the Examiner rejected claims 1, 6, and 21 under 35 U.S.C. 102(b) as being anticipated by Hiller et al. (US 6,233,024). In particular, the Examiner argued that Hiller teaches, in Figure 4, an off-axis projection system for displaying an optical image on a display surface based on input image data. The Examiner further argued that the system comprises: a) an image processing unit for receiving the input image data and generating distortion-compensated image data (see column 2, lines 56-67); b) a projection light engine (1) coupled to the image processing unit for receiving the distortion-compensated image data and projecting a distortion-compensated optical image that corresponds to the distortion-compensated image data; and, c) an optical reflection assembly 3 (also see figure 6) coupled to the projection light engine, the optical reflection assembly including at least one curved mirror (see 3 in Figure 4), the curved mirror being positioned in the optical path of the distortion-compensated optical image emerging from a projection lens for producing a displayed optical image with reduced distortion on the display surface. The Examiner further argued that the image processing unit is adapted to distortion-compensate the optical image represented by the input image data such that when the distortion-compensated optical image is projected through the projection light engine and reflected off the optical reflection assembly, the optical and geometric distortions associated with the projection light engine and the optical reflection assembly are substantially eliminated in the displayed optical image (see column 2, lines 56-67).

In response, the Applicant respectfully submits that amended claim 1 now recites that the optical reflection assembly comprises at least one curved mirror including an aspherical rotationally non-symmetric mirror having a vertically oriented concave surface and a horizontally oriented surface with at least one of a varying degree of concave and convex curvature on an upper surface that smoothly transitions to a varying degree of convex curvature on a lower surface for reducing spatial distortion on the displayed optical image.

The Applicant submits that such an aspherical rotationally non-symmetric mirror having the characteristics recited in claim 1 is not taught by Hiller. Hiller simply teaches using a curved mirror but does not give additional detail for the configuration of the curved mirror.

Accordingly, the Applicant respectfully submits that claim 1 is novel and inventive over Hiller and should be allowed. Further, since claims 3-12, and 16-20 depend from claim 1 and introduce other patentable features, the Applicant respectfully submits that claims 3-12, and 16-20 are also allowable.

Further, since independent claims 21 and 39 recite the aspherical rotationally non-symmetric mirror, the Applicant respectfully submits that these claims should also be allowable. Also, since claims 23-30 and 34-38 depend from claim 21 and since claims 40-42 depend from claim 39, and since these claims recite other patentable features, the Applicant respectfully submits that claims 23-30, 34-38 and 40-42 should also be allowed.

Claim Rejections – 35 USC § 103

In paragraph 11 of the Office Action, the Examiner rejected claims 2-4, 7-12, 16, 22-30 and 34 under 35 U.S.C. 103(a) as being unpatentable over Hiller et al. as applied to claims 1, 6, and 21 above. In particular, the Examiner argued that Sunaga (US 2002/0008853) teaches an aspherical rotationally non-symmetric mirror in paragraphs 16-19 and in Figure 7 which, the Examiner feels, clearly shows a concave and convex mirror R4 that meets the Applicant's claim language.

The Examiner further argued that Sunaga teaches that since the projection systems designs of Hiller are difficult to aberration correct and when the correction is made, the reflecting optical system tends not to be bright (see paragraph 11). The Examiner then argued that since the projection system of Sunaga does not suffer from the deficiencies,

it would have been obvious to one of skilled in the art at the time the invention was made to use the reflective projection system of Sunaga in the rear-projection system which utilizes an off-axis projection system taught by Hiller.

In response, the Applicant submits that a person skilled in the art would not think to combine the Sunaga and Hiller references. Hiller teaches a rear projector which uses at most two mirrors. On the other hand, Sunaga teaches a projection optical system that uses an oblique projection method with typically six reflecting surfaces. Sunaga further teaches that a minimum of three reflecting surfaces are needed which teaches away from the configuration taught by Hiller. Accordingly, someone skilled in the art would not think to combine these two references.

Furthermore, the Applicant submits that Sunaga only teaches a mirror having a plurality of rotation-asymmetrical reflecting surfaces that either have a convex or concave curvature (see par. 154, 155, 169 and 172). Sunaga doesn't teach the shape of the horizontal curvature of these mirrors. In addition, Sunaga teaches that there must be at least three such surfaces (see second last sentence in par. 153 on page 9). The Applicant submits that Sunaga is only teaching a few specific types of rotationally asymmetric mirrors and does not teach the type of rotationally asymmetric mirror of the subject invention.

In contrast, claim 1 of the subject invention recites an optical reflection assembly including an aspherical rotationally non-symmetric mirror having a vertically oriented concave surface and a horizontally oriented surface with a varying degree of concave or convex curvature on an upper surface that smoothly transitions to a varying degree of convex curvature on a lower surface. The Applicant cannot find a teaching of a mirror having this shape in Sunaga and respectfully requests that the Examiner review the Sunaga reference and explicitly point out where such a teaching exists or remove this rejection. It is further submitted that it is very questionable that a person skilled in the art

could take the teachings of Sunaga and arrive at the mirror recited in claim 1 of the subject invention without any experimentation, imagination or inventing.

Furthermore, claim 3 of the subject application recites that the aspherical rotationally non-symmetric mirror has a small degree of horizontal convex curvature on an upper portion and a larger degree of horizontal convex curvature on a lower portion for reducing spatial distortion on the displayed optical image. Claim 23 is the corresponding method claim. The Applicant submits that a mirror having this shape is not taught by Sunaga. Accordingly, the Applicant respectfully requests that the Examiner review the Sunaga reference and explicitly point out where such a teaching exists or remove the rejection to claims 3 and 23.

Also, claim 4 specifies that the projection system further comprises a corrector lens positioned in the optical path of the distortion-compensated optical image between the projection light engine and the at least one curved mirror, and that the corrector lens is shaped to compensate for the defocusing caused by the aspherical rotationally non-symmetric curved mirror. Claim 24 is the corresponding method claim. The Applicant submits that such a corrector lens can not be taught by Sunaga since Sunaga does not teach the aspherical rotationally non-symmetric curved mirror. Accordingly, the Applicant respectfully requests that the Examiner review the Sunaga reference and explicitly point out where such a teaching exists or remove the rejection to claims 4 and 24.

Accordingly, the Applicant respectfully submits that claim 1 is novel and inventive over the cited reference and should be allowed. Further, since claims 3-12, and 16-20 depend from claim 1 and introduce other patentable features, the Applicant respectfully submits that claims 3-12, and 16-20 are also allowable. Also, since independent claims 21 and 39 recite the aspherical rotationally non-symmetric mirror, as well as other patentable features, the Applicant respectfully submits that these claims should also be allowable. Also, since claims 23-30 and 34-38 depend from claim 21 and since claims

40-42 depend from claim 39, and since these claims also introduce patentable features, the Applicant respectfully submits that claims 23-30, 34-38 and 40-42 should also be allowed.

In paragraph 12 of the Office Action, the Examiner rejected claims 5, 17, and 35 under 35 U.S.C. 103(a) as being unpatentable over Hiller et al. as applied to claims 1, 6 and 21, and further in view of Suzuki et al. (US 2004/0046944). In particular the Examiner argued that Suzuki teaches a projection optical system including a mirror (16) and a lens (15) (see Figure 1). The Examiner argued that Suzuki teaches, in paragraphs 22-26, that the lens is an aspherical lens which is designed to cancel the curvature of field of the reflecting part. The Examiner argued that since it is desirable to eliminate such aberrations, it would have been obvious to include the lens of Suzuki in the projector of Hiller.

In response, the Applicant submits that there is no motivation to combine the Hiller and Suzuki references. Suzuki teaches the use of a refracting optical lens and a corresponding specially designed curved convex mirror in a projecting optical system to correct for pincushion distortion of the curved convex mirror whereas Hiller teaches the use of curved mirrors along with a computing device for recalculating the video picture prior to projection to compensate for distortion caused by the reflecting surfaces used in the projector system. Accordingly, Suzuki and Hiller teach two different techniques to correct for distortion and that someone skilled in the art would not think to combine these references.

In addition, the Applicant submits that Suzuki does not teach a mirror as claimed in claim 1 and that claim 5 of the subject invention claims an aspherical rotationally non-symmetric lens being shaped to compensate for any defocusing caused by the aspherical rotationally non-symmetric mirror. Since Suzuki does not teach such a mirror as claimed in claim 1, then the Applicant submits that Suzuki cannot possibly teach a

lens as claimed in claim 5 of the subject application. Accordingly, the Applicant submits that claim 5 is novel and inventive over the cited reference.

In paragraph 13 of the Office Action, the Examiner rejected claims 18-20 and 36-38 under 35 U.S.C. 103(a) as being unpatentable over Hiller et al. as applied to claims 1, 6 and 21 further in view of Nishizawa (U.S. 2004/0032982). In particular, the Examiner argued that Nishizawa teaches in paragraphs 12-14 that it is beneficial for the image processing unit to include a luminance correction stage which individually processes different spectral pass bands for correcting the unnatural image displayed by the prior art. The Examiner further argued that it would have been obvious to one skilled in the art at the time the invention was made to include the luminance correction of Nishizawa in the image processing unit of Hiller.

In response, the Applicant submits that Nishizawa does not teach an image warping stage. Nishizawa is only concerned with luminance correction. Further, the Applicant submits that there is no motivation to combine the Hiller and Nishizawa references. Hiller is directed towards correcting for any distortions due to using oblique projection and/or curved mirrors. Nishizawa is directed towards luminance correction for a moving image which is separate and distinct from the geometrical errors that are the focus of the Hiller reference. Accordingly, the Applicant submits that it would not be obvious for one skilled in the art to combine the Hiller and Nishizawa references since these references are directed towards different problems.

Accordingly, the Applicant respectfully submits that claims 18 and 36 are novel and inventive over the cited references and should be allowed.

Further, the Applicant submits that Nishizawa does not teach a luminance correction stage that processes different spectral passbands of input image data as recited in claims 19 and 37 of the subject application. Firstly, paragraphs 12-14 of Nishizawa teach the use of a luminance histogram for determining whether a scene change has

occurred. These paragraphs do not teach processing the luminance data on a frequency band level. Secondly, paragraph 164 of Nishizawa teaches a luminance converting unit 32 that includes two latch units, a selector circuits, a comparator, accumulators and a multiplier. There is no mention of any structure that can provide different frequency bands or filtering. Accordingly, it is clear that Nishizawa does not teach processing different spectral passbands of input image data.

Accordingly, the Applicant respectfully submits that claims 19 and 37 are novel and inventive over the cited references and should be allowed.

With regards to claim 20, it is clear that Nishizawa does not teach image warping. Further, while Hiller mentions using a computing device for recalculating a video picture prior to projection so that there appears on the screen a virtually undistorted video picture, Hiller does not teach processing different spectral passbands.

Accordingly, the Applicant respectfully submits that claims 20 and 38 are novel and inventive over the cited references and should be allowed.

Additional References Made of Record

The Applicant has briefly reviewed the other references cited by the Examiner and feels that they are not relevant to the claimed subject matter of the subject invention.

Peterson et al. (U.S. 6,896,375) teach a rear projection display device including a wide angle lens system and one or more planar mirrors that are parallel to a screen on which the image is to be displayed.

Shibazaki (U.S. 5,477,394) teaches a projector which emits light that is refracted by a converging lens to converge at a focal point of an elliptical mirror, and then travels

toward a secondary focal point of a parabolic mirror, through a projection lens to a Fresnel lens and then onto a lenticular lens-screen.

Bassi et al. (U.S. 2003/0231261) teach a short throw projection system and method for displaying a corrected optical image on a projection screen based on input image data that includes an electronic correction unit, an image processor and a reflection assembly.

Conclusion

In view of the foregoing, the Applicant respectfully submits that the application is now in condition for allowance and request that a timely Notice of Allowance be issued in this case. If the Examiner feels that a telephone discussion would be helpful to resolve any issues, he is respectfully requested to contact the attorney of record.

I certify that the foregoing document and any document(s) referenced below are being mailed by first-class mail, postage-prepaid, to the address stated above on the date stated below.

Dated: October 24, 2005

Respectfully submitted,



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Enclosure: Appendix: Replacement and Annotated Drawing Sheets

Appl. No. 10/752,955
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APPENDIX: REPLACEMENT AND ANNOTATED DRAWING SHEETS